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**IS 13730 ( Part 0/Sec 1 ) : 1993**
**IEC Pub 317-0-1 ( 1990 )**
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भारतीय मानक

# कुंडलन तारों के विशेष प्रकारों की विशिष्टि

**भाग 0 सामान्य अपेक्षाएं**

**अनुभाग 1 इनैमल गोल तांबे के तार**

*Indian Standard*

# SPECIFICATIONS FOR PARTICULAR TYPES OF WINDING WIRES

## PART 0 GENERAL REQUIREMENTS

### Section 1 Enamelled Round Copper Wire

( First Reprint SEPTEMBER 2000 )

UDC 621·315·337·4 : 621·315·55 [ 669·3 ] : 621·3·045

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**BUREAU OF INDIAN STANDARDS**
**MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG**
**NEW DELHI 110002**

***October* 1993** **Price Group 10**

Winding Wires Sectional Committee, ETD 33

## NATIONAL FOREWORD

This Indian Standard which is identical with IEC Pub 317-0-1 issued by the International Electrotechnical Commission was adopted by the Bureau of Indian Standards on the recommendation of the Winding Wires Sectional Committee (ETD 33) and approval of the Electrotechnical Division Council.

Presently requirements of enamelled round and enamelled rectangular winding wires are covered under IS 4800 series and IS 3855 series respectively, which were published in sixties. Over the years, changes in technology and developments resulted in publishing of number of amendments to these standards. Even though Indian Standards were following the developments in IEC level, but for some specific properties namely resistivity of copper, methods of test, etc, IEC Standards were not adopted in totality. In the present context it was decided to adopt IEC Standards in totality. In addition to this series, methods of tests ( IEC 851 series ) standards were decided to adopt without deviation. With the publication of this series and also other related series, corresponding parts of IS 4800 series and IS 3855 series would be withdrawn.

The text of IEC standard has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are however not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma ( , ) has been used as a decimal marker while in Indian Standards, the current practice is to use a point ( . ) as the decimal marker.

## CROSS REFERENCES

The Technical Committee responsible for the preparation of this standard has reviewed the provision of the list of IEC standards referred to in 2 and has decided that they are acceptable for use in conjunction with this standard.

ISO 3 : 1973 which is referred to in 2, read in the respective place IS 1076 ( Part 1 ) : 1985 which is identical with the ISO standard.

Reference to Clause 5 Electrical Resistance, requirements for resistance measurement shall apply to all sizes of wires. For conductor dia up to and including 1·000 mm provisions in 5 shall apply. For conductor dia above 1·000 mm only maximum resistance to be considered based on calculation given in C-2.

Amendment No. 1 issued to IEC Pub 317-0-1 is given at the end.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values ( *revised* )'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

# IEC
# 317-0-1

## Amendment 1

Page 17

*Replace table 2 by the following:*

Table 2 – Dimensions of enamelled wires with a bonding layer (R20)

| Nominal conductor diameter mm | Conductor tolerance ± mm | Minimum increase underlying coating mm | | Minimum increase bonding layer mm | Maximum overall diameter mm | |
|---|---|---|---|---|---|---|
| | | Grade 1B | Grade 2B | | Grade 1B | Grade 2B |
| 0,020 | | | | | 0,026 | 0,029 |
| 0,022 | | | | | 0,030 | 0,033 |
| 0,025 | | | | | 0,034 | 0,037 |
| 0,028 | | | | | 0,038 | 0,042 |
| 0,032 | | | | | 0,044 | 0,048 |
| 0,036 | | | | | 0,050 | 0,055 |
| 0,040 | | | | | 0,055 | 0,060 |
| 0,045 | | | | | 0,062 | 0,068 |
| 0,050 | | | | | 0,068 | 0,074 |
| 0,056 | | | | | 0,075 | 0,082 |
| 0,063 | | | | | 0,085 | 0,092 |
| 0,071 | 0,003 | 0,007 | 0,012 | 0,006 | 0,094 | 0,101 |
| 0,080 | 0,003 | 0,007 | 0,014 | 0,007 | 0,105 | 0,112 |
| 0,090 | 0,003 | 0,008 | 0,015 | 0,007 | 0,117 | 0,125 |
| 0,100 | 0,003 | 0,008 | 0,016 | 0,007 | 0,129 | 0,137 |
| 0,112 | 0,003 | 0,009 | 0,017 | 0,008 | 0,143 | 0,152 |
| 0,125 | 0,003 | 0,010 | 0,019 | 0,009 | 0,158 | 0,168 |
| 0,140 | 0,003 | 0,011 | 0,021 | 0,010 | 0,175 | 0,186 |
| 0,160 | 0,003 | 0,012 | 0,023 | 0,010 | 0,197 | 0,209 |
| 0,180 | 0,003 | 0,013 | 0,025 | 0,010 | 0,220 | 0,233 |

### Table 2 *(concluded)*

| Nominal conductor diameter mm | Conductor tolerance ± mm | Minimum increase underlying coating mm | | Minimum increase bonding layer mm | Maximum overall diameter mm | |
|---|---|---|---|---|---|---|
| | | *Grade 1B* | *Grade 2B* | | Grade 1B | Grade 2B |
| 0,200 | 0,003 | 0,014 | 0,027 | 0,011 | 0,243 | 0,256 |
| 0,224 | 0,003 | 0,015 | 0,029 | 0,012 | 0,270 | 0,284 |
| 0,250 | 0,004 | 0,017 | 0,032 | 0,013 | 0,300 | 0,316 |
| 0,280 | 0,004 | 0,018 | 0,033 | 0,013 | 0,331 | 0,348 |
| 0,315 | 0,004 | 0,019 | 0,035 | 0,014 | 0,369 | 0,387 |
| 0,355 | 0,004 | 0,020 | 0,038 | 0,015 | 0,413 | 0,432 |
| 0,400 | 0,005 | 0,021 | 0,040 | 0,016 | 0,461 | 0,481 |
| 0,450 | 0,005 | 0,022 | 0,042 | 0,016 | 0,514 | 0,536 |
| 0,500 | 0,005 | 0,024 | 0,045 | 0,017 | 0,568 | 0,590 |
| 0,560 | 0,006 | 0,025 | 0,047 | 0,017 | 0,630 | 0,654 |
| 0,630 | 0,006 | 0,027 | 0,050 | 0,018 | 0,704 | 0,729 |
| 0,710 | 0,007 | 0,028 | 0,053 | 0,019 | 0,788 | 0,815 |
| 0,800 | 0,008 | 0,030 | 0,056 | 0,020 | 0,882 | 0,911 |
| 0,900 | 0,009 | 0,032 | 0,060 | 0,020 | 0,987 | 1,017 |
| 1,000 | 0,010 | 0,034 | 0,063 | 0,021 | 1,091 | 1,123 |
| 1,120 | 0,011 | 0,034 | 0,065 | 0,022 | 1,214 | 1,247 |
| 1,250 | 0,013 | 0,035 | 0,067 | 0,022 | 1,346 | 1,379 |
| 1,400 | 0,014 | 0,036 | 0,069 | 0,023 | 1,499 | 1,533 |
| 1,600 | 0,016 | 0,038 | 0,071 | 0,023 | 1,702 | 1,738 |
| 1,800 | 0,018 | 0,039 | 0,073 | 0,024 | 1,905 | 1,942 |
| 2,000 | 0,020 | 0,040 | 0,075 | 0,025 | 2,108 | 2,146 |

NOTES

1 National Committees may use minimum overall diameter requirements provided they are based on the minimum increase. The calculation is given in annex B.

2 For intermediate nominal conductor diameters, the *minimum increase figure corresponding* to the next largest nominal conductor diameter shall be taken.

3 The dimensions of intermediate nominal conductor diameters for R40 series are given in annex A.

**Page 25**

*Replace table 6 by the following:*

Table 6 – Mandrel diameters

| Nominal conductor diameter mm | | Elongation before winding on mandrel % | Mandrel diameter |
|---|---|---|---|
| Over | Up to and including | | |
| – | 0,050 | 20* | 0,150 mm |
| 0,050 | 0,063 | 15* | 0,150 mm |
| 0,063 | 0,080 | 10 | 0,150 mm |
| 0,080 | 0,112 | 5 | 0,150 mm |
| 0,112 | 0,140 | 0 | 0,150 mm |
| 0,140 | 1,600 | 0 | d ** |

* Or to the breaking-point of copper, whichever is less.

** d = nominal conductor diameter of the wire.

Page 27

*Replace table 7 by the following:*

Table 7 – Mandrel diameters

| Nominal conductor diameter<br>mm | Mandrel diameter<br>mm |
|---|---|
| 0,160 | 0,250 |
| 0,180 | 0,280 |
| 0,200 | 0,315 |
| 0,224 | 0,355 |
| 0,250 | 0,400 |
| 0,280 | 0,630 |
| 0,315 | 0,710 |
| 0,355 | 0,800 |
| 0,400 | 0,900 |
| 0,450 | 1,000 |
| 0,500 | 1,120 |
| 0,560 | 1,250 |
| 0,630 | 1,400 |
| 0,710 | 1,600 |
| 0,800 | 1,800 |
| 0,900 | 2,000 |
| 1,000 | 2,240 |
| 1,120 | 3,550 |
| 1,250 | 4,000 |
| 1,400 | 4,500 |
| 1,600 | 5,000 |

NOTES

1 For nominal conductor diameters up to and including 0,140 mm, table 6 shall be applied.

2 For intermediate nominal conductor diameters, the mandrel diameter of the next largest nominal conductor diameter shall be taken.

Page 39

Table A.1 *(concluded)*

*Amend, in the fourth column,* 0,075 *to* 0,077 *corresponding to the nominal conductor diameter 2,120.*

**Pages 39 and 41**

***Replace table A.2 by the following:***

Table A.2 – Dimensions of enamelled wires with a bonding layer (R40)

| Nominal conductor diameter | Conductor tolerance ± | Minimum increase underlying coating mm | | Minimum increase bonding layer | Maximum overall diameter mm | |
|---|---|---|---|---|---|---|
| mm | mm | Grade 1B | Grade 2B | mm | Grade 1B | Grade 2B |
| 0,021 | | | | | 0,029 | 0,031 |
| 0,024 | | | | | 0,032 | 0,035 |
| 0,027 | | | | | 0,037 | 0,040 |
| 0,030 | | | | | 0,042 | 0,046 |
| 0,034 | | | | | 0,047 | 0,052 |
| 0,038 | | | | | 0,052 | 0,057 |
| 0,043 | | | | | 0,059 | 0,065 |
| 0,048 | | | | | 0,067 | 0,073 |
| 0,053 | | | | | 0,072 | 0,078 |
| 0,060 | | | | | 0,081 | 0,088 |
| 0,067 | 0,003 | 0,007 | 0,012 | 0,006 | 0,090 | 0,098 |
| 0,075 | 0,003 | 0,007 | 0,014 | 0,007 | 0,100 | 0,106 |
| 0,085 | 0,003 | 0,008 | 0,015 | 0,007 | 0,112 | 0,119 |
| 0,095 | 0,003 | 0,008 | 0,016 | 0,007 | 0,123 | 0,131 |
| 0,106 | 0,003 | 0,009 | 0,017 | 0,008 | 0,136 | 0,145 |
| 0,118 | 0,003 | 0,010 | 0,019 | 0,009 | 0,150 | 0,159 |
| 0,132 | 0,003 | 0,011 | 0,021 | 0,010 | 0,167 | 0,177 |
| 0,150 | 0,003 | 0,012 | 0,023 | 0,010 | 0,186 | 0,197 |
| 0,170 | 0,003 | 0,013 | 0,025 | 0,010 | 0,210 | 0,221 |
| 0,190 | 0,003 | 0,014 | 0,027 | 0,011 | 0,233 | 0,245 |
| 0,212 | 0,003 | 0,015 | 0,029 | 0,012 | 0,258 | 0,272 |
| 0,236 | 0,004 | 0,017 | 0,032 | 0,013 | 0,286 | 0,302 |
| 0,265 | 0,004 | 0,018 | 0,033 | 0,013 | 0,316 | 0,333 |
| 0,300 | 0,004 | 0,019 | 0,035 | 0,014 | 0,354 | 0,372 |
| 0,335 | 0,004 | 0,020 | 0,038 | 0,015 | 0,393 | 0,412 |
| 0,375 | 0,005 | 0,021 | 0,040 | 0,016 | 0,436 | 0,456 |
| 0,425 | 0,005 | 0,022 | 0,042 | 0,016 | 0,489 | 0,511 |
| 0,475 | 0,005 | 0,024 | 0,045 | 0,017 | 0,543 | 0,565 |
| 0,530 | 0,006 | 0,025 | 0,047 | 0,017 | 0,600 | 0,624 |
| 0,600 | 0,006 | 0,027 | 0,050 | 0,018 | 0,674 | 0,699 |
| 0,670 | 0,007 | 0,028 | 0,053 | 0,019 | 0,748 | 0,775 |
| 0,750 | 0,008 | 0,030 | 0,056 | 0,020 | 0,832 | 0,861 |
| 0,850 | 0,009 | 0,032 | 0,060 | 0,020 | 0,937 | 0,967 |
| 0,950 | 0,010 | 0,034 | 0,063 | 0,021 | 1,041 | 1,073 |
| 1,060 | 0,011 | 0,034 | 0,065 | 0,022 | 1,154 | 1,187 |
| 1,180 | 0,012 | 0,035 | 0,067 | 0,022 | 1,276 | 1,309 |
| 1,320 | 0,013 | 0,036 | 0,069 | 0,023 | 1,419 | 1,453 |
| 1,500 | 0,015 | 0,038 | 0,071 | 0,023 | 1,602 | 1,638 |
| 1,700 | 0,017 | 0,039 | 0,073 | 0,024 | 1,805 | 1,842 |
| 1,900 | 0,019 | 0,040 | 0,075 | 0,025 | 2,008 | 2,046 |

**NOTE** - National Committees may use minimum overall diameter requirements provided they are based on the minimum increases. The calculation is given in annex B.

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# 317-0-1

## Amendment 1

Page 17

*Replace table 2 by the following:*

Table 2 – Dimensions of enamelled wires with a bonding layer (R20)

| Nominal conductor diameter | Conductor tolerance ± | Minimum increase underlying coating mm | | Minimum increase bonding layer | Maximum overall diameter mm | |
|---|---|---|---|---|---|---|
| mm | mm | Grade 1B | Grade 2B | mm | Grade 1B | Grade 2B |
| 0,020 | | | | | 0,026 | 0,029 |
| 0,022 | | | | | 0,030 | 0,033 |
| 0,025 | | | | | 0,034 | 0,037 |
| 0,028 | | | | | 0,038 | 0,042 |
| 0,032 | | | | | 0,044 | 0,048 |
| 0,036 | | | | | 0,050 | 0,055 |
| 0,040 | | | | | 0,055 | 0,060 |
| 0,045 | | | | | 0,062 | 0,068 |
| 0,050 | | | | | 0,068 | 0,074 |
| 0,056 | | | | | 0,075 | 0,082 |
| 0,063 | | | | | 0,085 | 0,092 |
| 0,071 | 0,003 | 0,007 | 0,012 | 0,006 | 0,094 | 0,101 |
| 0,080 | 0,003 | 0,007 | 0,014 | 0,007 | 0,105 | 0,112 |
| 0,090 | 0,003 | 0,008 | 0,015 | 0,007 | 0,117 | 0,125 |
| 0,100 | 0,003 | 0,008 | 0,016 | 0,007 | 0,129 | 0,137 |
| 0,112 | 0,003 | 0,009 | 0,017 | 0,008 | 0,143 | 0,152 |
| 0,125 | 0,003 | 0,010 | 0,019 | 0,009 | 0,158 | 0,168 |
| 0,140 | 0,003 | 0,011 | 0,021 | 0,010 | 0,175 | 0,186 |
| 0,160 | 0,003 | 0,012 | 0,023 | 0,010 | 0,197 | 0,209 |
| 0,180 | 0,003 | 0,013 | 0,025 | 0,010 | 0,220 | 0,233 |

Table 2 *(concluded)*

| Nominal conductor diameter<br>mm | Conductor tolerance ±<br>mm | Minimum increase underlying coating mm | | Minimum increase bonding layer<br>mm | Maximum overall diameter mm | |
|---|---|---|---|---|---|---|
| | | Grade 1B | Grade 2B | | Grade 1B | Grade 2B |
| 0,200 | 0,003 | 0,014 | 0,027 | 0,011 | 0,243 | 0,256 |
| 0,224 | 0,003 | 0,015 | 0,029 | 0,012 | 0,270 | 0,284 |
| 0,250 | 0,004 | 0,017 | 0,032 | 0,013 | 0,300 | 0,316 |
| 0,280 | 0,004 | 0,018 | 0,033 | 0,013 | 0,331 | 0,348 |
| 0,315 | 0,004 | 0,019 | 0,035 | 0,014 | 0,369 | 0,387 |
| 0,355 | 0,004 | 0,020 | 0,038 | 0,015 | 0,413 | 0,432 |
| 0,400 | 0,005 | 0,021 | 0,040 | 0,016 | 0,461 | 0,481 |
| 0,450 | 0,005 | 0,022 | 0,042 | 0,016 | 0,514 | 0,536 |
| 0,500 | 0,005 | 0,024 | 0,045 | 0,017 | 0,568 | 0,590 |
| 0,560 | 0,006 | 0,025 | 0,047 | 0,017 | 0,630 | 0,654 |
| 0,630 | 0,006 | 0,027 | 0,050 | 0,018 | 0,704 | 0,729 |
| 0,710 | 0,007 | 0,028 | 0,053 | 0,019 | 0,788 | 0,815 |
| 0,800 | 0,008 | 0,030 | 0,056 | 0,020 | 0,882 | 0,911 |
| 0,900 | 0,009 | 0,032 | 0,060 | 0,020 | 0,987 | 1,017 |
| 1,000 | 0,010 | 0,034 | 0,063 | 0,021 | 1,091 | 1,123 |
| 1,120 | 0,011 | 0,034 | 0,065 | 0,022 | 1,214 | 1,247 |
| 1,250 | 0,013 | 0,035 | 0,067 | 0,022 | 1,346 | 1,379 |
| 1,400 | 0,014 | 0,036 | 0,069 | 0,023 | 1,499 | 1,533 |
| 1,600 | 0,016 | 0,038 | 0,071 | 0,023 | 1,702 | 1,738 |
| 1,800 | 0,018 | 0,039 | 0,073 | 0,024 | 1,905 | 1,942 |
| 2,000 | 0,020 | 0,040 | 0,075 | 0,025 | 2,108 | 2,146 |

NOTES

1 National Committees may use minimum overall diameter requirements provided they are based on the minimum increase. The calculation is given in annex B.

2 For intermediate nominal conductor diameters, the minimum increase figure corresponding to the next largest nominal conductor diameter shall be taken.

3 The dimensions of intermediate nominal conductor diameters for R40 series are given in annex A.

**Page 25**

*Replace table 6 by the following:*

### Table 6 – Mandrel diameters

| Nominal conductor diameter mm | | Elongation before winding on mandrel % | Mandrel diameter |
|---|---|---|---|
| Over | Up to and including | | |
| – | 0,050 | 20* | 0,150 mm |
| 0,050 | 0,063 | 15* | 0,150 mm |
| 0,063 | 0,080 | 10 | 0,150 mm |
| 0,080 | 0,112 | 5 | 0,150 mm |
| 0,112 | 0,140 | 0 | 0,150 mm |
| 0,140 | 1,600 | 0 | d ** |

* Or to the breaking-point of copper, whichever is less.

** d = nominal conductor diameter of the wire.

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Page 27

*Replace table 7 by the following:*

Table 7 – Mandrel diameters

| Nominal conductor diameter<br>mm | Mandrel diameter<br>mm |
|---|---|
| 0,160 | 0,250 |
| 0,180 | 0,280 |
| 0,200 | 0,315 |
| 0,224 | 0,355 |
| 0,250 | 0,400 |
| 0,280 | 0,630 |
| 0,315 | 0,710 |
| 0,355 | 0,800 |
| 0,400 | 0,900 |
| 0,450 | 1,000 |
| 0,500 | 1,120 |
| 0,560 | 1,250 |
| 0,630 | 1,400 |
| 0,710 | 1,600 |
| 0,800 | 1,800 |
| 0,900 | 2,000 |
| 1,000 | 2,240 |
| 1,120 | 3,550 |
| 1,250 | 4,000 |
| 1,400 | 4,500 |
| 1,600 | 5,000 |

NOTES

1 For nominal conductor diameters up to and including 0,140 mm, table 6 shall be applied.

2 For intermediate nominal conductor diameters, the mandrel diameter of the next largest nominal conductor diameter shall be taken.

Page 39

Table A.1 *(concluded)*

*Amend, in the fourth column,* 0,075 *to* 0,077 *corresponding to the nominal conductc diameter 2,120.*

**Pages 39 and 41**

***Replace table A.2 by the following:***

Table A.2 – Dimensions of enamelled wires with a bonding layer (R40)

| Nominal conductor diameter | Conductor tolerance ± | Minimum increase underlying coating mm | | Minimum increase bonding layer | Maximum overall diameter mm | |
|---|---|---|---|---|---|---|
| mm | mm | Grade 1B | Grade 2B | mm | Grade 1B | Grade 2B |
| 0,021 | | | | | 0,029 | 0,031 |
| 0,024 | | | | | 0,032 | 0,035 |
| 0,027 | | | | | 0,037 | 0,040 |
| 0,030 | | | | | 0,042 | 0,046 |
| 0,034 | | | | | 0,047 | 0,052 |
| 0,038 | | | | | 0,052 | 0,057 |
| 0,043 | | | | | 0,059 | 0,065 |
| 0,048 | | | | | 0,067 | 0,073 |
| 0,053 | | | | | 0,072 | 0,078 |
| 0,060 | | | | | 0,081 | 0,088 |
| 0,067 | 0,003 | 0,007 | 0,012 | 0,006 | 0,090 | 0,098 |
| 0,075 | 0,003 | 0,007 | 0,014 | 0,007 | 0,100 | 0,106 |
| 0,085 | 0,003 | 0,008 | 0,015 | 0,007 | 0,112 | 0,119 |
| 0,095 | 0,003 | 0,008 | 0,016 | 0,007 | 0,123 | 0,131 |
| 0,106 | 0,003 | 0,009 | 0,017 | 0,008 | 0,136 | 0,145 |
| 0,118 | 0,003 | 0,010 | 0,019 | 0,009 | 0,150 | 0,159 |
| 0,132 | 0,003 | 0,011 | 0,021 | 0,010 | 0,167 | 0,177 |
| 0,150 | 0,003 | 0,012 | 0,023 | 0,010 | 0,186 | 0,197 |
| 0,170 | 0,003 | 0,013 | 0,025 | 0,010 | 0,210 | 0,221 |
| 0,190 | 0,003 | 0,014 | 0,027 | 0,011 | 0,233 | 0,245 |
| 0,212 | 0,003 | 0,015 | 0,029 | 0,012 | 0,258 | 0,272 |
| 0,236 | 0,004 | 0,017 | 0,032 | 0,013 | 0,286 | 0,302 |
| 0,265 | 0,004 | 0,018 | 0,033 | 0,013 | 0,316 | 0,333 |
| 0,300 | 0,004 | 0,019 | 0,035 | 0,014 | 0,354 | 0,372 |
| 0,335 | 0,004 | 0,020 | 0,038 | 0,015 | 0,393 | 0,412 |
| 0,375 | 0,005 | 0,021 | 0,040 | 0,016 | 0,436 | 0,456 |
| 0,425 | 0,005 | 0,022 | 0,042 | 0,016 | 0,489 | 0,511 |
| 0,475 | 0,005 | 0,024 | 0,045 | 0,017 | 0,543 | 0,565 |
| 0,530 | 0,006 | 0,025 | 0,047 | 0,017 | 0,600 | 0,624 |
| 0,600 | 0,006 | 0,027 | 0,050 | 0,018 | 0,674 | 0,699 |
| 0,670 | 0,007 | 0,028 | 0,053 | 0,019 | 0,748 | 0,775 |
| 0,750 | 0,008 | 0,030 | 0,056 | 0,020 | 0,832 | 0,861 |
| 0,850 | 0,009 | 0,032 | 0,060 | 0,020 | 0,937 | 0,967 |
| 0,950 | 0,010 | 0,034 | 0,063 | 0,021 | 1,041 | 1,073 |
| 1,060 | 0,011 | 0,034 | 0,065 | 0,022 | 1,154 | 1,187 |
| 1,180 | 0,012 | 0,035 | 0,067 | 0,022 | 1,276 | 1,309 |
| 1,320 | 0,013 | 0,036 | 0,069 | 0,023 | 1,419 | 1,453 |
| 1,500 | 0,015 | 0,038 | 0,071 | 0,023 | 1,602 | 1,638 |
| 1,700 | 0,017 | 0,039 | 0,073 | 0,024 | 1,805 | 1,842 |
| 1,900 | 0,019 | 0,040 | 0,075 | 0,025 | 2,008 | 2,046 |

**NOTE** - **National Committees may use minimum overall diameter requirements provided they are based on the minimum increases. The calculation is given in annex B.**

IS 13730 ( Part 0/Sec 1) : 1993
IEC Pub 317-0-1(1990)

# *Indian Standard*

# SPECIFICATIONS FOR PARTICULAR TYPES OF WINDING WIRES

## PART 0 GENERAL REQUIREMENTS

## Section 1 Enamelled Round Copper Wire

### 1 Scope

This International Standard specifies the general requirements of enamelled round copper winding wires with or without a bonding layer.

The range of nominal conductor diameters is given in the relevant specification sheet.

### 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid international standards.

IEC 172: 1987, *Test procedure for the determination of the temperature index of enamelled winding wires.*

IEC 317-1: 1990, *Specifications for particular types of winding wires - Part 1: Polyvinyl acetal enamelled round copper wire, class 105.*

IEC 317-2: 1990, *Specifications for particular types of winding wires - Part 2: Solderable polyurethane enamelled round copper wire, class 130, with a bonding layer.*

IEC 317-3: 1990, *Specifications for particular types of winding wires - Part 3: Polyester enamelled round copper wire, class 155.*

IEC 317-4: 1990, *Specifications for particular types of winding wires - Part 4: Solderable polyurethane enamelled round copper wire, class 130.*

IEC 317-7: 1990, *Specifications for particular types of winding wires - Part 7: Polyimide enamelled round copper wire, class 220.*

IEC 317-8: 1990, *Specifications for particular types of winding wires - Part 8: Polyesterimide enamelled round copper wire, class 180.*

IEC 317-12: 1990, *Specifications for particular types of winding wires - Part 12: Polyvinyl acetal enamelled round copper wire, class 120.*

IEC 317-13: 1990, *Specifications for particular types of winding wires - Part 13: Polyester or polyesterimide overcoated with polyamide-imide, enamelled round copper wire, class 200.*

IEC 317-19: 1990, *Specifications for particular types of winding wires - Part 19: Solderable polyurethane overcoated with polyamide enamelled round copper wire, class 130.*

IEC 317-20: 1990, *Specifications for particular types of winding wires - Part 20: Solderable polyurethane enamelled round copper wire, class 155.*

IEC 317-21: 1990, *Specifications for particular types of winding wires - Part 21: Solderable polyurethane overcoated with polyamide enamelled round copper wire, class 155.*

IEC 317-22: 1990, *Specifications for particular types of winding wires - Part 22: Polyester or polyesterimide enamelled round copper wire overcoated with polyamide, class 180.*

IEC 317-23: 1990, *Specifications for particular types of winding wires - Part 23: Solderable polyesterimide enamelled round copper wire, class 180.*

IEC 317-26: 1990, *Specifications for particular types of winding wires - Part 26: Polyamide-imide enamelled round copper wire, class 200.*

IEC 317-34: 1990, *Specifications for particular types of winding wires - Part 34: Polyester enamelled round copper wire, class 130.*

IEC 851, *Methods of test for winding wires.*

ISO 3: 1973, *Preferred numbers - Series of preferred numbers.*

## 3 Definitions and general notes on methods of test

### 3.1 *Definitions*

*Conductor*

The bare metal after removal of the coating.

*Crack*

An opening in the insulation which exposes the conductor to view at the stated magnification.

*Sole coating*

An insulation composed of one material.

*Wire*

The insulated wire as received.

### 3.2 *General notes on methods of test*

All methods of test to be used for this standard are given in IEC 851.

The clause numbers used in this standard are identical with the respective test numbers of IEC 851.

In case of inconsistencies between the publication on methods of test and this standard, IEC 317-0-1 shall prevail.

Where no specific range of nominal conductor diameters is given for a test, the test applies to all nominal conductor diameters covered by the specification sheet.

Unless otherwise specified, all tests shall be carried out at a temperature from 15 °C to 35 °C and a relative humidity from 45 % to 75 %. Before measurements are made, the specimens shall be preconditioned under these atmospheric conditions for a time sufficient to allow the specimens to reach stability.

The wire to be tested shall be removed from the packaging in such a way that the wire will not be subjected to tension or unnecessary bends. Before each test, sufficient wire should be discarded to ensure that any damaged wire is not included in the test specimens.

## 4 Dimensions

### 4.1 *Conductor diameter*

The series of preferred nominal conductor diameters shall correspond to series R20 according to ISO 3. The actual values and their tolerances are given in tables 1 and 2.

The series of intermediate diameters from which the user may select intermediate nominal conductor diameters, when required for technical reasons, shall correspond to series R40 according to ISO 3. The actual values and their tolerances are given in annex A.

The conductor diameter shall not differ from the nominal diameter by more than the limit given in tables 1 or 2.

NOTE - For wires up to and including 0,063 mm nominal conductor diameter, see table 3.

## Table 1 - Dimensions of enamelled wires (R20)

| Nominal conductor diameter mm | Conductor tolerance ± mm | Minimum increase due to the insulation mm | | | Maximum overall diameter mm | | |
|---|---|---|---|---|---|---|---|
| | | Grade 1 | Grade 2 | Grade 3 | Grade 1 | Grade 2 | Grade 3 |
| 0,018 | | | | | 0,022 | 0,024 | |
| 0,020 | | | | | 0,024 | 0,027 | |
| 0,022 | | | | | 0,027 | 0,030 | |
| 0,025 | | | | | 0,031 | 0,034 | |
| 0,028 | | | | | 0,034 | 0,038 | |
| 0,032 | | | | | 0,039 | 0,043 | |
| 0,036 | | | | | 0,044 | 0,049 | |
| 0,040 | | | | | 0,049 | 0,054 | |
| 0,045 | | | | | 0,055 | 0,061 | |
| 0,050 | | | | | 0,060 | 0,066 | |
| 0,056 | | | | | 0,067 | 0,074 | |
| 0,063 | | | | | 0,076 | 0,083 | |
| 0,071 | 0,003 | 0,007 | 0,012 | 0,018 | 0,084 | 0,091 | 0,097 |
| 0,080 | 0,003 | 0,007 | 0,014 | 0,020 | 0,094 | 0,101 | 0,108 |
| 0,090 | 0,003 | 0,008 | 0,015 | 0,022 | 0,105 | 0,113 | 0,120 |
| 0,100 | 0,003 | 0,008 | 0,016 | 0,023 | 0,117 | 0,125 | 0,132 |
| 0,112 | 0,003 | 0,009 | 0,017 | 0,026 | 0,130 | 0,139 | 0,147 |
| 0,125 | 0,003 | 0,010 | 0,019 | 0,028 | 0,144 | 0,154 | 0,163 |
| 0,140 | 0,003 | 0,011 | 0,021 | 0,030 | 0,160 | 0,171 | 0,181 |
| 0,160 | 0,003 | 0,012 | 0,023 | 0,033 | 0,182 | 0,194 | 0,205 |
| 0,180 | 0,003 | 0,013 | 0,025 | 0,036 | 0,204 | 0,217 | 0,229 |
| 0,200 | 0,003 | 0,014 | 0,027 | 0,039 | 0,226 | 0,239 | 0,252 |
| 0,224 | 0,003 | 0,015 | 0,029 | 0,043 | 0,252 | 0,266 | 0,280 |
| 0,250 | 0,004 | 0,017 | 0,032 | 0,048 | 0,281 | 0,297 | 0,312 |
| 0,280 | 0,004 | 0,018 | 0,033 | 0,050 | 0,312 | 0,329 | 0,345 |
| 0,315 | 0,004 | 0,019 | 0,035 | 0,053 | 0,349 | 0,367 | 0,384 |
| 0,355 | 0,004 | 0,020 | 0,038 | 0,057 | 0,392 | 0,411 | 0,428 |
| 0,400 | 0,005 | 0,021 | 0,040 | 0,060 | 0,439 | 0,459 | 0,478 |
| 0,450 | 0,005 | 0,022 | 0,042 | 0,064 | 0,491 | 0,513 | 0,533 |
| 0,500 | 0,005 | 0,024 | 0,045 | 0,067 | 0,544 | 0,566 | 0,587 |
| 0,560 | 0,006 | 0,025 | 0,047 | 0,071 | 0,606 | 0,630 | 0,653 |
| 0,630 | 0,006 | 0,027 | 0,050 | 0,075 | 0,679 | 0,704 | 0,728 |
| 0,710 | 0,007 | 0,028 | 0,053 | 0,080 | 0,762 | 0,789 | 0,814 |
| 0,800 | 0,008 | 0,030 | 0,056 | 0,085 | 0,855 | 0,884 | 0,911 |
| 0,900 | 0,009 | 0,032 | 0,060 | 0,090 | 0,959 | 0,989 | 1,018 |
| 1,000 | 0,010 | 0,034 | 0,063 | 0,095 | 1,062 | 1,094 | 1,124 |
| 1,120 | 0,011 | 0,034 | 0,065 | 0,098 | 1,184 | 1,217 | 1,248 |
| 1,250 | 0,013 | 0,035 | 0,067 | 0,100 | 1,316 | 1,349 | 1,381 |
| 1,400 | 0,014 | 0,036 | 0,069 | 0,103 | 1,468 | 1,502 | 1,535 |
| 1,600 | 0,016 | 0,038 | 0,071 | 0,107 | 1,670 | 1,706 | 1,740 |
| 1,800 | 0,018 | 0,039 | 0,073 | 0,110 | 1,872 | 1,909 | 1,944 |
| 2,000 | 0,020 | 0,040 | 0,075 | 0,113 | 2,074 | 2,112 | 2,148 |
| 2,240 | 0,022 | 0,041 | 0,077 | 0,116 | 2,316 | 2,355 | 2,392 |
| 2,500 | 0,025 | 0,042 | 0,079 | 0,119 | 2,578 | 2,618 | 2,656 |
| 2,800 | 0,028 | 0,043 | 0,081 | 0,123 | 2,880 | 2,922 | 2,961 |
| 3,150 | 0,032 | 0,045 | 0,084 | 0,127 | 3,233 | 3,276 | 3,316 |
| 3,550 | 0,036 | 0,046 | 0,086 | 0,130 | 3,635 | 3,679 | 3,721 |
| 4,000 | 0,040 | 0,047 | 0,089 | 0,134 | 4,088 | 4,133 | 4,176 |
| 4,500 | 0,045 | 0,049 | 0,092 | 0,138 | 4,591 | 4,637 | 4,681 |
| 5,000 | 0,050 | 0,050 | 0,094 | 0,142 | 5,093 | 5,141 | 5,186 |

NOTES

1 National Committees may use minimum overall diameter requirements provided they are based on the minimum increases. The calculation is given in annex B.

2 For intermediate nominal conductor diameters, the minimum increase figure corresponding to the next largest nominal conductor diameter shall be taken.

3 The dimensions of intermediate nominal conductor diameters for R40 series are given in annex A.

## Table 2 - Dimensions of enamelled wires with a bonding layer (R20)

| Nominal conductor diameter mm | Conductor tolerance ± mm | Minimum increase mm | | Maximum overall diameter mm | |
|---|---|---|---|---|---|
| | | Grade 1B | Grade 2B | Grade 1B | Grade 2B |
| 0,020 | | | | 0,026 | 0,029 |
| 0,022 | | | | 0,030 | 0,033 |
| 0,025 | | | | 0,034 | 0,037 |
| 0,028 | | | | 0,038 | 0,042 |
| 0,032 | | | | 0,044 | 0,048 |
| 0,036 | | | | 0,050 | 0,055 |
| 0,040 | | | | 0,055 | 0,060 |
| 0,045 | | | | 0,062 | 0,068 |
| 0,050 | | | | 0,068 | 0,074 |
| 0,056 | | | | 0,075 | 0,082 |
| 0,063 | | | | 0,085 | 0,092 |
| 0,071 | 0,003 | 0,017 | 0,022 | 0,094 | 0,101 |
| 0,080 | 0,003 | 0,018 | 0,025 | 0,105 | 0,112 |
| 0,090 | 0,003 | 0,020 | 0,027 | 0,117 | 0,125 |
| 0,100 | 0,003 | 0,020 | 0,028 | 0,129 | 0,137 |
| 0,112 | 0,003 | 0,022 | 0,030 | 0,143 | 0,152 |
| 0,125 | 0,003 | 0,024 | 0,033 | 0,158 | 0,168 |
| 0,140 | 0,003 | 0,026 | 0,036 | 0,175 | 0,186 |
| 0,160 | 0,003 | 0,027 | 0,038 | 0,197 | 0,209 |
| 0,180 | 0,003 | 0,029 | 0,041 | 0,220 | 0,233 |
| 0,200 | 0,003 | 0,031 | 0,044 | 0,243 | 0,256 |
| 0,224 | 0,003 | 0,033 | 0,047 | 0,270 | 0,284 |
| 0,250 | 0,004 | 0,036 | 0,051 | 0,300 | 0,316 |
| 0,280 | 0,004 | 0,037 | 0,052 | 0,331 | 0,348 |
| 0,315 | 0,004 | 0,039 | 0,055 | 0,369 | 0,387 |
| 0,355 | 0,004 | 0,041 | 0,059 | 0,413 | 0,432 |
| 0,400 | 0,005 | 0,043 | 0,062 | 0,461 | 0,481 |
| 0,450 | 0,005 | 0,045 | 0,065 | 0,514 | 0,536 |
| 0,500 | 0,005 | 0,048 | 0,069 | 0,568 | 0,590 |
| 0,560 | 0,006 | 0,049 | 0,071 | 0,630 | 0,654 |
| 0,630 | 0,006 | 0,052 | 0,075 | 0,704 | 0,729 |
| 0,710 | 0,007 | 0,054 | 0,079 | 0,788 | 0,815 |
| 0,800 | 0,008 | 0,057 | 0,083 | 0,882 | 0,911 |
| 0,900 | 0,009 | 0,060 | 0,088 | 0,987 | 1,017 |
| 1,000 | 0,010 | 0,063 | 0,092 | 1,091 | 1,123 |
| 1,120 | 0,011 | 0,064 | 0,095 | 1,214 | 1,247 |
| 1,250 | 0,013 | 0,065 | 0,097 | 1,346 | 1,379 |
| 1,400 | 0,014 | 0,067 | 0,100 | 1,499 | 1,533 |
| 1,600 | 0,016 | 0,070 | 0,103 | 1,702 | 1,738 |
| 1,800 | 0,018 | 0,072 | 0,106 | 1,905 | 1,942 |
| 2,000 | 0,020 | 0,074 | 0,109 | 2,108 | 2,146 |

NOTES

1 National Committees may use minimum overall diameter requirements provided they are based on the minimum increases. The calculation is given in annex B.

2 For intermediate nominal conductor diameters, the minimum increase figure corresponding to the next largest nominal conductor diameter shall be taken.

3 The dimensions of intermediate nominal conductor diameters for R40 series are given in annex A.

### 4.2 *Out of roundness of conductor* (nominal conductor diameters over 0,063 mm)

The difference between the minimum and maximum diameter, at any one point, shall not be more than the figure given in column 2 of table 1 or table 2.

### 4.3 *Minimum increase in diameter due to the insulation and the bonding layer* (nominal conductor diameters over 0,063 mm)

#### 4.3.1 *Enamelled wires without a bonding layer*

The minimum increase in diameter due to the insulation shall not be less than the values given in table 1.

#### 4.3.2 *Enamelled wires with a bonding layer*

The minimum increase in diameter due to the insulation including the bonding layer shall not be less than the values given in table 2.

### 4.4 *Maximum overall diameter*

#### 4.4.1 *Enamelled wires without a bonding layer*

The maximum overall diameter shall not exceed the values given in table 1.

#### 4.4.2 *Enamelled wires with a bonding layer*

The maximum overall diameter shall not exceed the values given in table 2.

## 5 Electrical resistance

For nominal conductor diameters up to and including 0,063 mm the resistance at 20 °C shall be within the limits given in table 3.

For nominal conductor diameters greater than 0,063 mm no resistance values are specified.

By agreement between purchaser and supplier, resistance measurements may be made for nominal conductor diameters over 0,063 mm up to and including 1,000 mm. In case of such an agreement, the resistance at 20 °C shall be within the limits given in annex D.

Table 3 - Electrical resistances

| Nominal conductor diameter | Resistance Ω/m | | Nominal conductor diameter | Resistance Ω/m | |
|---|---|---|---|---|---|
| mm | Min. | Max. | mm | Min. | Max. |
| 0,018 | 60,46 | 73,89 | 0,036 | 15,16 | 18,42 |
| 0,020 | 48,97 | 59,85 | 0,040 | 12,28 | 14,92 |
| 0,022 | 40,47 | 49,47 | 0,045 | 9,705 | 11,79 |
| 0,025 | 31,34 | 38,31 | 0,050 | 7,922 | 9,489 |
| 0,028 | 24,99 | 30,54 | 0,056 | 6,316 | 7,565 |
| 0,032 | 19,13 | 23,38 | 0,063 | 5,045 | 5,922 |

NOTES

1 The limits shown in table 3 are derived from calculations made according to annex C.

2 For the nominal resistance, see annex D.

## 6 Elongation

The elongation at fracture shall not be less than the value given in table 4.

Table 4 - Elongation

| Nominal conductor diameter mm | Elongation minimum % | Nominal conductor diameter mm | Elongation minimum % | Nominal conductor diameter mm | Elongation minimum % |
|---|---|---|---|---|---|
| 0,018 | 5 | 0,180 | 20 | 1,800 | 32 |
| 0,020 | 6 | 0,200 | 21 | 2,000 | 33 |
| 0,022 | 6 | 0,224 | 21 | 2,240 | 33 |
| 0,025 | 7 | 0,250 | 22 | 2,500 | 33 |
| 0,028 | 7 | 0,280 | 22 | 2,800 | 34 |
| 0,032 | 8 | 0,315 | 23 | 3,150 | 34 |
| 0,036 | 8 | 0,355 | 23 | 3,550 | 35 |
| 0,040 | 9 | 0,400 | 24 | 4,000 | 35 |
| 0,045 | 9 | 0,450 | 25 | 4,500 | 36 |
| 0,050 | 10 | 0,500 | 25 | 5,000 | 36 |
| 0,056 | 10 | 0,560 | 26 | | |
| 0,063 | 12 | 0,630 | 27 | | |
| 0,071 | 13 | 0,710 | 28 | | |
| 0,080 | 14 | 0,800 | 28 | | |
| 0,090 | 15 | 0,900 | 29 | | |
| 0,100 | 16 | 1,000 | 30 | | |
| 0,112 | 17 | 1,120 | 30 | | |
| 0,125 | 17 | 1,250 | 31 | | |
| 0,140 | 18 | 1,400 | 32 | | |
| 0,160 | 19 | 1,600 | 32 | | |

NOTE - For intermediate nominal conductor diameters, the elongation value of the next largest nominal conductor diameter shall be taken.

## 7 Springiness

### 7.1 *Nominal conductor diameters from 0,080 mm up to and including 1,600 mm*

The wire shall not exceed the maximum springback as given in table 5, when tested on the mandrel required using the specified tension.

Table 5 - Springiness

| Nominal conductor diameter mm | Mandrel diameter mm | Tension N | Maximum springback degrees | | |
|---|---|---|---|---|---|
| | | | Grade 1 | Grade 2 and grade 1B | Grade 3 and grade 2B |
| 0,080 | 5 | 0,25 | 70 | 80 | 100 |
| 0,090 | | | 67 | 77 | 94 |
| 0,100 | | | 64 | 73 | 90 |
| 0,112 | 7 | 0,50 | 64 | 73 | 88 |
| 0,125 | | | 62 | 70 | 84 |
| 0,140 | | | 59 | 67 | 79 |
| 0,160 | 10 | 1,0 | 59 | 67 | 78 |
| 0,180 | | | 57 | 65 | 75 |
| 0,200 | | | 54 | 62 | 72 |
| 0,224 | 12,5 | 2,0 | 51 | 59 | 68 |
| 0,250 | | | 49 | 56 | 65 |
| 0,280 | | | 47 | 53 | 61 |
| 0,315 | 19 | 4,0 | 50 | 55 | 62 |
| 0,355 | | | 48 | 53 | 59 |
| 0,400 | | | 45 | 50 | 55 |
| 0,450 | 25 | 8,0 | 44 | 48 | 53 |
| 0,500 | | | 43 | 47 | 51 |
| 0,560 | | | 41 | 44 | 48 |
| 0,630 | 37,5 | 12,0 | 46 | 50 | 53 |
| 0,710 | | | 44 | 47 | 50 |
| 0,800 | | | 41 | 43 | 46 |
| 0,900 | 50 | 15,0 | 45 | 48 | 51 |
| 1,000 | | | 42 | 45 | 47 |
| 1,120 | | | 39 | 41 | 43 |
| 1,250 | | | 35 | 37 | 39 |
| 1,400 | | | 32 | 34 | 36 |
| 1,600 | | | 28 | 30 | 32 |

NOTE - For intermediate nominal conductor diameters, the springback figure of the next largest nominal conductor diameter shall be taken.

### 7.2 *Nominal conductor diameters over 1,600 mm*

The wire shall not exceed the maximum springback of 5 degrees.

## 8 Flexibility and adherence

### 8.1 *Mandrel winding test* (nominal conductor diameters up to and including 1,600 mm)

The coating shall show no crack after the wire has been elongated as specified in table 6 and wound on the appropriate mandrel.

Table 6 - Mandrel winding

| Nominal conductor diameter mm | | Elongation before winding on mandrel % | Mandrel diameter ** |
|---|---|---|---|
| Over | Up to and including | | |
| – | 0,050 | 20 * | 0,150 mm |
| 0,050 | 1,600 | – | *D* |

* Or to the breaking point of the copper, whichever is less.

** *D* is the overall diameter of the wire.

### 8.2 *Stretching test* (nominal conductor diameters over 1,600 mm)

The coating shall show no crack after the wire has been elongated 32 %.

### 8.3 *Jerk test* (nominal conductor diameters up to and including 1,000 mm)

The coating shall show no crack or loss of adhesion.

### 8.4 *Peel test* (nominal conductor diameters over 1,000 mm)

The coating shall show no loss of adhesion after the specimen has been subjected to the number of revolutions $R$ required by its nominal conductor diameter $d_{\text{nom}}$:

$$R = \frac{K}{d_{\text{nom}}}$$ rounded down to a whole number of revolutions.

The constant $K$ used for the calculation is given in the relevant specification sheet.

## 9 Heat shock

### 9.1 *Nominal conductor diameters up to and including 1,600 mm*

The coating shall show no crack. The mandrel diameter shall be as specified in table 7. The minimum heat shock temperature is given in the relevant specification sheet.

Table 7 - Heat shock

| Nominal conductor diameter mm | | Mandrel diameter ** |
|---|---|---|
| Over | Up to and including | |
| – | 0,040 | 0,150 mm * |
| 0,040 | 0,160 | 3*D* * |
| 0,160 | 0,250 | 4*D* * |
| 0,250 | 1,000 | 2*D* |
| 1,000 | 1,600 | 3*D* |

* Before winding on the mandrel, the specimen shall be stretched 20 % or to the breaking point of the copper, whichever is less.

** *D* is the overall diameter of the wire

### 9.2 *Nominal conductor diameters over 1,600 mm*

The coating shall show no crack after having been elongated 25 %. The minimum heat shock temperature is given in the relevant specification sheet.

## 10 Cut-through

For requirements see the relevant specification sheet.

## 11 Resistance to abrasion

For requirements see the relevant specification sheet.

## 12 Resistance to solvents

*Standard solvent*

Using a pencil of hardness "H" the coating shall not be removed.

## 13 Breakdown voltage

The wire shall meet the requirements given in 13.1, 13.2 and 13.3, respectively, when tested at room temperature and at elevated temperature when this is required by the purchaser.

The elevated temperature is given in the relevant specification sheet.

### 13.1 *Nominal conductor diameters up to and including 0,100 mm*

At least four of the five specimens tested shall not break down at a voltage less than or equal to that given in table 8.

Table 8 - Breakdown voltage

| Nominal conductor diameter | Minimum breakdown voltage (root-mean-square value) (r.m.s.) V | | |
|---|---|---|---|
| | Grade 1 and grade 1B | Grade 2 and grade 2B | Grade 3 |
| mm | At room temperature | | |
| 0,018 | 110 | 225 | - |
| 0,020 | 120 | 250 | - |
| 0,022 | 130 | 275 | - |
| 0,025 | 150 | 300 | - |
| 0,028 | 170 | 325 | - |
| 0,032 | 190 | 375 | - |
| 0,036 | 225 | 425 | - |
| 0,040 | 250 | 475 | - |
| 0,045 | 275 | 550 | - |
| 0,050 | 300 | 600 | - |
| 0,056 | 325 | 650 | - |
| 0,063 | 375 | 700 | - |
| 0,071 | 425 | 700 | 1 100 |
| 0,080 | 425 | 850 | 1 200 |
| 0,090 | 500 | 900 | 1 300 |
| 0,100 | 500 | 950 | 1 400 |

NOTE - For intermediate nominal conductor diameters, the figure of the next largest nominal conductor diameter shall be taken.

### 13.2 *Nominal conductor diameters over 0,100 mm up to and including 2,500 mm*

At least four of the five specimens tested shall not break down at a voltage less than or equal to that given in table 9.

Table 9 - Breakdown voltage

| Nominal conductor diameter<br>mm | Minimum breakdown voltage (r.m.s. value)<br>V | | | | | |
|---|---|---|---|---|---|---|
| | Grade 1 and grade 1B | | Grade 2 and grade 2B | | Grade 3 | |
| | Room temperature | Elevated temperature | Room temperature | Elevated temperature | Room temperature | Elevated temperature |
| 0,112 | 1 300 | 1 000 | 2 700 | 2 000 | 3 900 | 2 900 |
| 0,125 | 1 500 | 1 100 | 2 800 | 2 100 | 4 100 | 3 100 |
| 0,140 | 1 600 | 1 200 | 3 000 | 2 300 | 4 200 | 3 200 |
| 0,160 | 1 700 | 1 300 | 3 200 | 2 400 | 4 400 | 3 300 |
| 0,180 | 1 700 | 1 300 | 3 300 | 2 500 | 4 700 | 3 500 |
| 0,200 | 1 800 | 1 400 | 3 500 | 2 600 | 5 100 | 3 800 |
| 0,224 | 1 900 | 1 400 | 3 700 | 2 800 | 5 200 | 3 900 |
| 0,250 | 2 100 | 1 600 | 3 900 | 2 900 | 5 500 | 4 100 |
| 0,280 | 2 200 | 1 700 | 4 000 | 3 000 | 5 800 | 4 400 |
| 0,315 | 2 200 | 1 700 | 4 100 | 3 100 | 6 100 | 4 600 |
| 0,355 | 2 300 | 1 700 | 4 300 | 3 200 | 6 400 | 4 800 |
| 0,400 | 2 300 | 1 700 | 4 400 | 3 300 | 6 600 | 5 000 |
| 0,450 | 2 300 | 1 700 | 4 400 | 3 300 | 6 800 | 5 100 |
| 0,500 | 2 400 | 1 800 | 4 600 | 3 500 | 7 000 | 5 300 |
| 0,560 | 2 500 | 1 900 | 4 600 | 3 500 | 7 100 | 5 300 |
| 0,630 | 2 600 | 2 000 | 4 800 | 3 600 | 7 100 | 5 300 |
| 0,710 | 2 600 | 2 000 | 4 800 | 3 600 | 7 200 | 5 400 |
| 0,800 | 2 600 | 2 000 | 4 900 | 3 700 | 7 400 | 5 600 |
| 0,900 | 2 700 | 2 000 | 5 000 | 3 800 | 7 600 | 5 700 |
| 1,000 up to and including 2,500 | 2 700 | 2 000 | 5 000 | 3 800 | 7 600 | 5 700 |

NOTE - For intermediate nominal conductor diameters, the figure of the next largest nominal conductor diameter shall be taken.

### 13.3 *Nominal conductor diameters over 2,500 mm*

At least four of the five specimens tested shall not break down at a voltage less than or equal to that given in table 10.

Table 10 - Breakdown voltage

| Nominal conductor diameter<br>mm | Minimum breakdown voltage (r.m.s. value)<br>V | | | | | |
|---|---|---|---|---|---|---|
| | Grade 1 and grade 1B | | Grade 2 and grade 2B | | Grade 3 | |
| | Room temperature | Elevated temperature | Room temperature | Elevated temperature | Room temperature | Elevated temperature |
| over 2,500 | 1 300 | 1 000 | 2 500 | 1 900 | 3 800 | 2 900 |

## 14 Continuity of insulation (nominal conductor diameters up to and including 1,600 mm)

The number of faults per 30 m of wire shall not exceed the values given in table 11.

Table 11 - Continuity of insulation

| Nominal conductor diameter mm | | Maximum number of faults per 30 m | | |
|---|---|---|---|---|
| Over | Up to and including | Grade 1 and grade 1B | Grade 2 and grade 2B | Grade 3 |
| – | 0,050 | 60 | 24 | – |
| 0,050 | 0,080 | 60 | 24 | 3 |
| 0,080 | 0,125 | 40 | 15 | 3 |
| 0,125 | 1,600 | 25 | 5 | 3 |

## 15 Temperature index

The test shall be carried out on a wire having a nominal conductor diameter of 1,000 mm, grade 2, unless otherwise agreed between purchaser and supplier.

When unvarnished specimens are tested in accordance with the method given in IEC 172, the temperature corresponding to an extrapolated life of 20 000 h shall not be less than the temperature given in the relevant specification sheet and the measured life at the lowest test temperature shall not be less than 5 000 h.

When required by a purchaser, the supplier of the enamelled wire shall supply evidence that the wire meets the requirements for the temperature index.

NOTE - The temperature index requirement based on an extrapolated life of 20 000 h relates to enamelled wires tested unvarnished and not as part of an insulation system. The temperature in degrees Celsius corresponding to the temperature index is not necessarily that at which it is recommended that the wire be operated and this will depend on many factors, including the type of equipment involved.

## 16 Resistance to refrigerants

For requirements see the relevant specification sheet.

## 17 Solderability

For requirements see the relevant specification sheet.

## 18 Heat or solvent bonding

For requirements see the relevant specification sheet.

## 19 Dielectric dissipation factor

For requirements see the relevant specification sheet.

## 20 Resistance to transformer oil

For requirements see the relevant specification sheet.

## 21 Loss of mass

For requirements see the relevant specification sheet.

## 22 High temperature failure

For requirements see the relevant specification sheet.

## 30 Packaging

The kind of packaging may influence certain properties of the wire, for example spring-back. Therefore the kind of packaging, for example the type of spool, shall be agreed between purchaser and supplier.

The wire shall be evenly and compactly wound on spools or placed in containers. No spool or container shall contain more than one length of wire unless agreed to by purchaser and supplier. Marking of the label when there is more than one length and/or identification of the separate lengths in the package, shall be agreed to by purchaser and supplier.

Where wires are delivered in coils, the dimensions and the maximum weights of such coils shall be agreed between purchaser and supplier. Any additional protection for coils shall also be agreed between purchaser and supplier.

# Annex A
(informative)

## Dimensions for intermediate nominal conductor diameters (R40)

Intermediate nominal conductor diameters from which the user may select intermediate sizes only for technical reasons.

### A.1 Enamelled wires without a bonding layer

Table A.1 - Dimensions of enamelled wires (R40)

| Nominal conductor diameter mm | Conductor tolerance ± mm | Minimum increase due to the insulation mm | | | Maximum overall diameter mm | | |
|---|---|---|---|---|---|---|---|
| | | Grade 1 | Grade 2 | Grade 3 | Grade 1 | Grade 2 | Grade 3 |
| 0,019 | | | | | 0,023 | 0,026 | |
| 0,021 | | | | | 0,026 | 0,028 | |
| 0,024 | | | | | 0,029 | 0,032 | |
| 0,027 | | | | | 0,033 | 0,036 | |
| 0,030 | | | | | 0,037 | 0,041 | |
| 0,034 | | | | | 0,041 | 0,046 | |
| 0,038 | | | | | 0,046 | 0,051 | |
| 0,043 | | | | | 0,052 | 0,058 | |
| 0,048 | | | | | 0,059 | 0,065 | |
| 0,053 | | | | | 0,064 | 0,070 | |
| 0,060 | | | | | 0,072 | 0,079 | |
| 0,067 | 0,003 | 0,007 | 0,012 | 0,018 | 0,080 | 0,088 | |
| 0,075 | 0,003 | 0,007 | 0,014 | 0,020 | 0,089 | 0,095 | 0,102 |
| 0,085 | 0,003 | 0,008 | 0,015 | 0,022 | 0,100 | 0,107 | 0,114 |
| 0,095 | 0,003 | 0,008 | 0,016 | 0,023 | 0,111 | 0,119 | 0,126 |
| 0,106 | 0,003 | 0,009 | 0,017 | 0,026 | 0,123 | 0,132 | 0,140 |
| 0,118 | 0,003 | 0,010 | 0,019 | 0,028 | 0,136 | 0,145 | 0,154 |
| 0,132 | 0,003 | 0,011 | 0,021 | 0,030 | 0,152 | 0,162 | 0,171 |
| 0,150 | 0,003 | 0,012 | 0,023 | 0,033 | 0,171 | 0,182 | 0,193 |
| 0,170 | 0,003 | 0,013 | 0,025 | 0,036 | 0,194 | 0,205 | 0,217 |
| 0,190 | 0,003 | 0,014 | 0,027 | 0,039 | 0,216 | 0,228 | 0,240 |
| 0,212 | 0,003 | 0,015 | 0,029 | 0,043 | 0,240 | 0,254 | 0,268 |
| 0,236 | 0,004 | 0,017 | 0,032 | 0,048 | 0,267 | 0,283 | 0,298 |
| 0,265 | 0,004 | 0,018 | 0,033 | 0,050 | 0,297 | 0,314 | 0,330 |
| 0,300 | 0,004 | 0,019 | 0,035 | 0,053 | 0,334 | 0,352 | 0,369 |
| 0,335 | 0,004 | 0,020 | 0,038 | 0,057 | 0,372 | 0,391 | 0,408 |
| 0,375 | 0,005 | 0,021 | 0,040 | 0,060 | 0,414 | 0,434 | 0,453 |
| 0,425 | 0,005 | 0,022 | 0,042 | 0,064 | 0,466 | 0,488 | 0,508 |
| 0,475 | 0,005 | 0,024 | 0,045 | 0,067 | 0,519 | 0,541 | 0,562 |
| 0,530 | 0,006 | 0,025 | 0,047 | 0,071 | 0,576 | 0,600 | 0,623 |
| 0,600 | 0,006 | 0,027 | 0,050 | 0,075 | 0,649 | 0,674 | 0,698 |
| 0,670 | 0,007 | 0,028 | 0,053 | 0,080 | 0,722 | 0,749 | 0,774 |
| 0,750 | 0,008 | 0,030 | 0,056 | 0,085 | 0,805 | 0,834 | 0,861 |
| 0,850 | 0,009 | 0,032 | 0,060 | 0,090 | 0,909 | 0,939 | 0,968 |
| 0,950 | 0,010 | 0,034 | 0,063 | 0,095 | 1,012 | 1,044 | 1,074 |

## Table A.1 (concluded)

| Nominal conductor diameter mm | Conductor tolerance ± mm | Minimum increase due to the insulation mm | | | Maximum overall diameter mm | | |
|---|---|---|---|---|---|---|---|
| | | Grade 1 | Grade 2 | Grade 3 | Grade 1 | Grade 2 | Grade 3 |
| 1,060 | 0,011 | 0,034 | 0,065 | 0,098 | 1,124 | 1,157 | 1,188 |
| 1,180 | 0,012 | 0,035 | 0,067 | 0,100 | 1,246 | 1,279 | 1,311 |
| 1,320 | 0,013 | 0,036 | 0,069 | 0,103 | 1,388 | 1,422 | 1,455 |
| 1,500 | 0,015 | 0,038 | 0,071 | 0,107 | 1,570 | 1,606 | 1,640 |
| 1,700 | 0,017 | 0,039 | 0,073 | 0,110 | 1,772 | 1,809 | 1,844 |
| 1,900 | 0,019 | 0,040 | 0,075 | 0,113 | 1,974 | 2,012 | 2,048 |
| 2,120 | 0,021 | 0,041 | 0,077 | 0,116 | 2,196 | 2,235 | 2,272 |
| 2,360 | 0,024 | 0,042 | 0,079 | 0,119 | 2,438 | 2,478 | 2,516 |
| 2,650 | 0,027 | 0,043 | 0,081 | 0,123 | 2,730 | 2,772 | 2,811 |
| 3,000 | 0,030 | 0,045 | 0,084 | 0,127 | 3,083 | 3,126 | 3,166 |
| 3,350 | 0,034 | 0,046 | 0,086 | 0,130 | 3,435 | 3,479 | 3,521 |
| 3,750 | 0,038 | 0,047 | 0,089 | 0,134 | 3,838 | 3,883 | 3,926 |
| 4,250 | 0,043 | 0,049 | 0,092 | 0,138 | 4,341 | 4,387 | 4,431 |
| 4,750 | 0,048 | 0,050 | 0,094 | 0,142 | 4,843 | 4,891 | 4,936 |

NOTE - National Committees may use minimum overall diameter requirements provided they are based on the minimum increases. The calculation is given in annex B.

## A.2 Enamelled wires with a bonding layer

### Table A.2 - Dimensions of enamelled wires with a bonding layer (R40)

| Nominal conductor diameter mm | Conductor tolerance ± mm | Minimum increase mm | | Maximum overall diameter mm | |
|---|---|---|---|---|---|
| | | Grade 1B | Grade 2B | Grade 1B | Grade 2B |
| 0,021 | | | | 0,029 | 0,031 |
| 0,024 | | | | 0,032 | 0,035 |
| 0,027 | | | | 0,037 | 0,040 |
| 0,030 | | | | 0,042 | 0,046 |
| 0,034 | | | | 0,047 | 0,052 |
| 0,038 | | | | 0,052 | 0,057 |
| 0,043 | | | | 0,059 | 0,065 |
| 0,048 | | | | 0,067 | 0,073 |
| 0,053 | | | | 0,072 | 0,078 |
| 0,060 | | | | 0,081 | 0,088 |
| 0,067 | 0,003 | 0,017 | 0,022 | 0,090 | 0,098 |
| 0,075 | 0,003 | 0,018 | 0,025 | 0,100 | 0,106 |
| 0,085 | 0,003 | 0,020 | 0,027 | 0,112 | 0,119 |
| 0,095 | 0,003 | 0,020 | 0,028 | 0,123 | 0,131 |
| 0,106 | 0,003 | 0,022 | 0,030 | 0,136 | 0,145 |
| 0,118 | 0,003 | 0,024 | 0,033 | 0,150 | 0,159 |
| 0,132 | 0,003 | 0,026 | 0,036 | 0,167 | 0,177 |
| 0,150 | 0,003 | 0,027 | 0,038 | 0,186 | 0,197 |
| 0,170 | 0,003 | 0,029 | 0,041 | 0,210 | 0,221 |
| 0,190 | 0,003 | 0,031 | 0,044 | 0,233 | 0,245 |

## Table A.2 (concluded)

| Nominal conductor diameter | Conductor tolerance ± | Minimum increase | | Maximum overall diameter mm | |
|---|---|---|---|---|---|
| mm | mm | Grade 1B | Grade 2B | Grade 1B | Grade 2B |
| 0,212 | 0,003 | 0,033 | 0,047 | 0,258 | 0,272 |
| 0,236 | 0,004 | 0,036 | 0,051 | 0,286 | 0,302 |
| 0,265 | 0,004 | 0,037 | 0,052 | 0,316 | 0,333 |
| 0,300 | 0,004 | 0,039 | 0,055 | 0,354 | 0,372 |
| 0,335 | 0,004 | 0,041 | 0,059 | 0,393 | 0,412 |
| 0,375 | 0,005 | 0,043 | 0,062 | 0,436 | 0,456 |
| 0,425 | 0,005 | 0,045 | 0,065 | 0,489 | 0,511 |
| 0,475 | 0,005 | 0,048 | 0,069 | 0,543 | 0,565 |
| 0,530 | 0,006 | 0,049 | 0,071 | 0,600 | 0,624 |
| 0,600 | 0,006 | 0,052 | 0,075 | 0,674 | 0,699 |
| 0,670 | 0,007 | 0,054 | 0,079 | 0,748 | 0,775 |
| 0,750 | 0,008 | 0,057 | 0,083 | 0,832 | 0,861 |
| 0,850 | 0,009 | 0,060 | 0,088 | 0,937 | 0,967 |
| 0,950 | 0,010 | 0,063 | 0,092 | 1,041 | 1,073 |
| 1,060 | 0,011 | 0,064 | 0,095 | 1,154 | 1,187 |
| 1,180 | 0,012 | 0,065 | 0,097 | 1,276 | 1,309 |
| 1,320 | 0,013 | 0,067 | 0,100 | 1,419 | 1,453 |
| 1,500 | 0,015 | 0,070 | 0,103 | 1,602 | 1,638 |
| 1,700 | 0,017 | 0,072 | 0,106 | 1,805 | 1,842 |
| 1,900 | 0,019 | 0,074 | 0,109 | 2,008 | 2,046 |

NOTE - National Committees may use minimum overall diameter requirements provided they are based on the minimum increases. The calculation is given in annex B.

# Annex B
## (informative)

## Method for the calculation of minimum overall diameter

### B.1 Enamelled wires without a bonding layer

The minimum overall diameters are calculated on the following basis:

grade 1: Nominal conductor diameter + minimum increase grade 1*;
grade 2: Maximum overall diameter grade 1 + 0,001 mm;
grade 3: Maximum overall diameter grade 2 + 0,001 mm.

* For nominal conductor diameters smaller than 0,071 mm the minimum increase figure for Grade 1 is 0,1 times the nominal conductor diameter.

### B.2 Enamelled wires with a bonding layer

The minimum overall diameters are calculated on the following basis:

grade 1B: Nominal conductor diameter + minimum increase grade 1B*;
grade 2B: Maximum overall diameter grade 1B + 0,001 mm.

* For nominal conductor diameters smaller than 0,071 mm the minimum increase figures for grade 1B are:

Table B.1 - Minimum increases

| Nominal conductor diameter mm | Minimum increase grade 1B mm |
|---|---|
| 0,020 | 0,004 |
| 0,022 | 0,005 |
| 0,025 | 0,006 |
| 0,028 | 0,007 |
| 0,032 | 0,008 |
| 0,036 | 0,010 |
| 0,040 | 0,010 |
| 0,045 | 0,012 |
| 0,050 | 0,013 |
| 0,056 | 0,014 |
| 0,063 | 0,015 |

NOTE - For intermediate nominal conductor diameters, the minimum increase figure corresponding to the next largest nominal conductor diameter shall be taken.

# Annex C
(informative)

## Method for the calculation of linear resistance

The limits of electrical resistance are calculated on the following basis:

### C.1 For nominal conductor diameters up to and including 0,063 mm

The values of the ratios:

$K_{min}$ of the minimum resistance to the nominal resistance, and

$K_{max}$ of the maximum resistance to the nominal resistance

are given for each nominal conductor diameter.

The linear resistance is calculated from:

$$R_{min} = K_{min} \times \rho_{nom} \times q_{nom}^{-1} \quad (\Omega\ m^{-1})$$

$$R_{max} = K_{max} \times \rho_{nom} \times q_{nom}^{-1} \quad (\Omega\ m^{-1})$$

where:

$K_{min}$ and $K_{max}$ have the values given in table C.1;

$\rho_{nom}$ is 1/58,5 $\Omega\ mm^2 \cdot m^{-1}$;

$q_{nom}$ is the cross-section of the conductor in square millimetres, calculated from $d_{nom}$ by

$$q_{nom} = \frac{\pi}{4} \times d_{nom}^2 .$$

Table C.1 - Ratios

| $d_{nom}$ mm | $K_{min}$ | $K_{max}$ |
|---|---|---|
| 0,018 | 0,900 | 1,100 |
| 0,020 | 0,900 | 1,100 |
| 0,022 | 0,900 | 1,100 |
| 0,025 | 0,900 | 1,100 |
| 0,028 | 0,900 | 1,100 |
| 0,032 | 0,900 | 1,100 |
| 0,036 | 0,903 | 1,097 |
| 0,040 | 0,903 | 1,097 |
| 0,045 | 0,903 | 1,097 |
| 0,050 | 0,910 | 1,090 |
| 0,056 | 0,910 | 1,090 |
| 0,063 | 0,920 | 1,080 |

## C.2 For nominal conductor diameters over 0,063 mm up to and including 1,000 mm

The minimum and the maximum values of resistance are calculated from the minimum anc maximum values of the resistivity by taking into account for each conductor diameter the relevant dimensional tolerance.

The linear resistance is calculated from:

$$R_{min} = \rho_{min} \times q_{max}^{-1} \quad (\Omega\ m^{-1})$$

$$R_{max} = \rho_{max} \times q_{min}^{-1} \quad (\Omega\ m^{-1})$$

where:

$\rho_{min}$ = 1/59 $\Omega$ mm$^2$ m$^{-1}$;
$\rho_{max}$ = 1/58 $\Omega$ mm$^2$ m$^{-1}$;
$q$ is the cross-section of the conductor in square millimetres.

# Annex D
(informative)

## Resistance

The figures for nominal resistance are given for information only. They are calculated on the basis of the nominal conductor diameter and a nominal resistivity of $1/58,5\ \Omega\ \text{mm}^2\ \text{m}^{-1}$

The minimum and maximum resistance figures for nominal conductor diameter over 0,063 mm up to and including 1,000 mm are derived from calculations made according to annex C.

Table D.1 - Electrical resistances

| Nominal conductor diameter mm | Resistance Ω/m | | | Nominal conductor diameter mm | Nominal resistance Ω/mm |
|---|---|---|---|---|---|
| | Minimum | Nominal | Maximum | | |
| 0,018 | - | 67,18 | - | 1,120 | 0,01735 |
| 0,020 | - | 54,41 | - | 1,250 | 0,01393 |
| 0,022 | - | 44,97 | - | 1,400 | 0,01110 |
| 0,025 | - | 34,82 | - | 1,600 | 0,008502 |
| 0,028 | - | 27,76 | - | 1,800 | 0,006718 |
| 0,032 | - | 21,25 | - | 2,000 | 0,005441 |
| 0,036 | - | 16,79 | - | 2,240 | 0,004338 |
| 0,040 | - | 13,60 | - | 2,500 | 0,003482 |
| 0,045 | - | 10,75 | - | 2,800 | 0,002776 |
| 0,050 | - | 8,706 | - | 3,150 | 0,002193 |
| 0,056 | - | 6,940 | - | 3,550 | 0,001727 |
| 0,063 | - | 5,484 | - | 4,000 | 0,001360 |
| 0,071 | 3,941 | 4,318 | 4,747 | 4,500 | 0,001075 |
| 0,080 | 3,133 | 3,401 | 3,703 | 5,000 | 0,0008706 |
| 0,090 | 2,495 | 2,687 | 2,900 | | |
| 0,100 | 2,034 | 2,176 | 2,333 | | |
| 0,112 | 1,632 | 1,735 | 1,848 | | |
| 0,125 | 1,317 | 1,393 | 1,476 | | |
| 0,140 | 1,055 | 1,110 | 1,170 | | |
| 0,160 | 0,8122 | 0,8502 | 0,8906 | | |
| 0,180 | 0,6444 | 0,6718 | 0,7007 | | |
| 0,200 | 0,5237 | 0,5441 | 0,5657 | | |
| 0,224 | 0,4188 | 0,4338 | 0,4495 | | |
| 0,250 | 0,3345 | 0,3482 | 0,3628 | | |
| 0,280 | 0,2676 | 0,2776 | 0,2882 | | |
| 0,315 | 0,2121 | 0,2193 | 0,2270 | | |
| 0,355 | 0,1674 | 0,1727 | 0,1782 | | |
| 0,400 | 0,1316 | 0,1360 | 0,1407 | | |
| 0,450 | 0,1042 | 0,1075 | 0,1109 | | |
| 0,500 | 0,08462 | 0,08706 | 0,08959 | | |
| 0,560 | 0,06736 | 0,06940 | 0,07153 | | |
| 0,630 | 0,05335 | 0,05484 | 0,05638 | | |
| 0,710 | 0,04198 | 0,04318 | 0,04442 | | |
| 0,800 | 0,03305 | 0,03401 | 0,03500 | | |
| 0,900 | 0,02612 | 0,02687 | 0,02765 | | |
| 1,000 | 0,02116 | 0,02176 | 0,02240 | | |

# IEC
# 317-0-1

## Amendment 1

Page 17

*Replace table 2 by the following:*

Table 2 – Dimensions of enamelled wires with a bonding layer (R20)

| Nominal conductor diameter | Conductor tolerance ± | Minimum increase underlying coating mm | | Minimum increase bonding layer | Maximum overall diameter mm | |
|---|---|---|---|---|---|---|
| mm | mm | Grade 1B | Grade 2B | mm | Grade 1B | Grade 2B |
| 0,020 | | | | | 0,026 | 0,029 |
| 0,022 | | | | | 0,030 | 0,033 |
| 0,025 | | | | | 0,034 | 0,037 |
| 0,028 | | | | | 0,038 | 0,042 |
| 0,032 | | | | | 0,044 | 0,048 |
| 0,036 | | | | | 0,050 | 0,055 |
| 0,040 | | | | | 0,055 | 0,060 |
| 0,045 | | | | | 0,062 | 0,068 |
| 0,050 | | | | | 0,068 | 0,074 |
| 0,056 | | | | | 0,075 | 0,082 |
| 0,063 | | | | | 0,085 | 0,092 |
| 0,071 | 0,003 | 0,007 | 0,012 | 0,006 | 0,094 | 0,101 |
| 0,080 | 0,003 | 0,007 | 0,014 | 0,007 | 0,105 | 0,112 |
| 0,090 | 0,003 | 0,008 | 0,015 | 0,007 | 0,117 | 0,125 |
| 0,100 | 0,003 | 0,008 | 0,016 | 0,007 | 0,129 | 0,137 |
| 0,112 | 0,003 | 0,009 | 0,017 | 0,008 | 0,143 | 0,152 |
| 0,125 | 0,003 | 0,010 | 0,019 | 0,009 | 0,158 | 0,168 |
| 0,140 | 0,003 | 0,011 | 0,021 | 0,010 | 0,175 | 0,186 |
| 0,160 | 0,003 | 0,012 | 0,023 | 0,010 | 0,197 | 0,209 |
| 0,180 | 0,003 | 0,013 | 0,025 | 0,010 | 0,220 | 0,233 |

Table 2 *(concluded)*

| Nominal conductor diameter | Conductor tolerance ± | Minimum increase underlying coating mm | | Minimum increase bonding layer | Maximum overall diameter mm | |
|---|---|---|---|---|---|---|
| mm | mm | Grade 1B | Grade 2B | mm | Grade 1B | Grade 2B |
| 0,200 | 0,003 | 0,014 | 0,027 | 0,011 | 0,243 | 0,256 |
| 0,224 | 0,003 | 0,015 | 0,029 | 0,012 | 0,270 | 0,284 |
| 0,250 | 0,004 | 0,017 | 0,032 | 0,013 | 0,300 | 0,316 |
| 0,280 | 0,004 | 0,018 | 0,033 | 0,013 | 0,331 | 0,348 |
| 0,315 | 0,004 | 0,019 | 0,035 | 0,014 | 0,369 | 0,387 |
| 0,355 | 0,004 | 0,020 | 0,038 | 0,015 | 0,413 | 0,432 |
| 0,400 | 0,005 | 0,021 | 0,040 | 0,016 | 0,461 | 0,481 |
| 0,450 | 0,005 | 0,022 | 0,042 | 0,016 | 0,514 | 0,536 |
| 0,500 | 0,005 | 0,024 | 0,045 | 0,017 | 0,568 | 0,590 |
| 0,560 | 0,006 | 0,025 | 0,047 | 0,017 | 0,630 | 0,654 |
| 0,630 | 0,006 | 0,027 | 0,050 | 0,018 | 0,704 | 0,729 |
| 0,710 | 0,007 | 0,028 | 0,053 | 0,019 | 0,788 | 0,815 |
| 0,800 | 0,008 | 0,030 | 0,056 | 0,020 | 0,882 | 0,911 |
| 0,900 | 0,009 | 0,032 | 0,060 | 0,020 | 0,987 | 1,017 |
| 1,000 | 0,010 | 0,034 | 0,063 | 0,021 | 1,091 | 1,123 |
| 1,120 | 0,011 | 0,034 | 0,065 | 0,022 | 1,214 | 1,247 |
| 1,250 | 0,013 | 0,035 | 0,067 | 0,022 | 1,346 | 1,379 |
| 1,400 | 0,014 | 0,036 | 0,069 | 0,023 | 1,499 | 1,533 |
| 1,600 | 0,016 | 0,038 | 0,071 | 0,023 | 1,702 | 1,738 |
| 1,800 | 0,018 | 0,039 | 0,073 | 0,024 | 1,905 | 1,942 |
| 2,000 | 0,020 | 0,040 | 0,075 | 0,025 | 2,108 | 2,146 |

NOTES

1 National Committees may use minimum overall diameter requirements provided they are based on the minimum increase. The calculation is given in annex B.

2 For intermediate nominal conductor diameters, the minimum increase figure corresponding to the next largest nominal conductor diameter shall be taken.

3 The dimensions of intermediate nominal conductor diameters for R40 series are given in annex A.

Page 25

*Replace table 6 by the following:*

Table 6 – Mandrel diameters

| Nominal conductor diameter mm | | Elongation before winding on mandrel % | Mandrel diameter |
|---|---|---|---|
| Over | Up to and including | | |
| – | 0,050 | 20* | 0,150 mm |
| 0,050 | 0,063 | 15* | 0,150 mm |
| 0,063 | 0,080 | 10 | 0,150 mm |
| 0,080 | 0,112 | 5 | 0,150 mm |
| 0,112 | 0,140 | 0 | 0,150 mm |
| 0,140 | 1,600 | 0 | d ** |

* Or to the breaking-point of copper, whichever is less.

** d = nominal conductor diameter of the wire.

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*Replace table 7 by the following:*

Table 7 – Mandrel diameters

| Nominal conductor diameter<br>mm | Mandrel diameter<br>mm |
|---|---|
| 0,160 | 0,250 |
| 0,180 | 0,280 |
| 0,200 | 0,315 |
| 0,224 | 0,355 |
| 0,250 | 0,400 |
| 0,280 | 0,630 |
| 0,315 | 0,710 |
| 0,355 | 0,800 |
| 0,400 | 0,900 |
| 0,450 | 1,000 |
| 0,500 | 1,120 |
| 0,560 | 1,250 |
| 0,630 | 1,400 |
| 0,710 | 1,600 |
| 0,800 | 1,800 |
| 0,900 | 2,000 |
| 1,000 | 2,240 |
| 1,120 | 3,550 |
| 1,250 | 4,000 |
| 1,400 | 4,500 |
| 1,600 | 5,000 |

NOTES

1 For nominal conductor diameters up to and including 0,140 mm, table 6 shall be applied.

2 For intermediate nominal conductor diameters, the mandrel diameter of the next largest nominal conductor diameter shall be taken.

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Table A.1 *(concluded)*

*Amend, in the fourth column,* 0,075 *to* 0,077 *corresponding to the nominal conductor diameter 2,120.*

**Pages 39 and 41**

***Replace table A.2 by the following:***

### Table A.2 – Dimensions of enamelled wires with a bonding layer (R40)

| Nominal conductor diameter<br>mm | Conductor tolerance ±<br>mm | Minimum increase underlying coating mm | | Minimum increase bonding layer<br>mm | Maximum overall diameter mm | |
|---|---|---|---|---|---|---|
| | | Grade 1B | Grade 2B | | Grade 1B | Grade 2B |
| 0,021 | | | | | 0,029 | 0,031 |
| 0,024 | | | | | 0,032 | 0,035 |
| 0,027 | | | | | 0,037 | 0,040 |
| 0,030 | | | | | 0,042 | 0,046 |
| 0,034 | | | | | 0,047 | 0,052 |
| 0.038 | | | | | 0,052 | 0,057 |
| 0,043 | | | | | 0,059 | 0,065 |
| 0,048 | | | | | 0,067 | 0,073 |
| 0,053 | | | | | 0,072 | 0,078 |
| 0,060 | | | | | 0,081 | 0,088 |
| 0,067 | 0,003 | 0,007 | 0,012 | 0,006 | 0,090 | 0,098 |
| 0,075 | 0,003 | 0,007 | 0,014 | 0,007 | 0,100 | 0,106 |
| 0,085 | 0,003 | 0,008 | 0,015 | 0,007 | 0,112 | 0,119 |
| 0,095 | 0,003 | 0,008 | 0,016 | 0,007 | 0,123 | 0,131 |
| 0,106 | 0,003 | 0,009 | 0,017 | 0,008 | 0,136 | 0,145 |
| 0,118 | 0,003 | 0,010 | 0,019 | 0,009 | 0,150 | 0,159 |
| 0,132 | 0,003 | 0,011 | 0,021 | 0,010 | 0,167 | 0,177 |
| 0,150 | 0,003 | 0,012 | 0,023 | 0,010 | 0,186 | 0,197 |
| 0,170 | 0,003 | 0,013 | 0,025 | 0,010 | 0,210 | 0,221 |
| 0,190 | 0,003 | 0,014 | 0,027 | 0,011 | 0,233 | 0,245 |
| 0,212 | 0,003 | 0,015 | 0,029 | 0,012 | 0,258 | 0,272 |
| 0,236 | 0,004 | 0,017 | 0,032 | 0,013 | 0,286 | 0,302 |
| 0,265 | 0,004 | 0,018 | 0,033 | 0,013 | 0,316 | 0,333 |
| 0,300 | 0,004 | 0,019 | 0,035 | 0,014 | 0,354 | 0,372 |
| 0,335 | 0,004 | 0,020 | 0,038 | 0,015 | 0,393 | 0,412 |
| 0,375 | 0,005 | 0,021 | 0,040 | 0,016 | 0,436 | 0,456 |
| 0,425 | 0,005 | 0,022 | 0,042 | 0,016 | 0,489 | 0,511 |
| 0,475 | 0,005 | 0,024 | 0,045 | 0,017 | 0,543 | 0,565 |
| 0,530 | 0,006 | 0,025 | 0,047 | 0,017 | 0,600 | 0,624 |
| 0,600 | 0,006 | 0,027 | 0,050 | 0,018 | 0,674 | 0,699 |
| 0,670 | 0,007 | 0,028 | 0,053 | 0,019 | 0,748 | 0,775 |
| 0,750 | 0,008 | 0,030 | 0,056 | 0,020 | 0,832 | 0,861 |
| 0,850 | 0,009 | 0,032 | 0,060 | 0,020 | 0,937 | 0,967 |
| 0,950 | 0,010 | 0,034 | 0,063 | 0,021 | 1,041 | 1,073 |
| 1,060 | 0,011 | 0,034 | 0,065 | 0,022 | 1,154 | 1,187 |
| 1,180 | 0,012 | 0,035 | 0,067 | 0,022 | 1,276 | 1,309 |
| 1,320 | 0,013 | 0,036 | 0,069 | 0,023 | 1,419 | 1,453 |
| 1,500 | 0,015 | 0,038 | 0,071 | 0,023 | 1,602 | 1,638 |
| 1,700 | 0,017 | 0,039 | 0,073 | 0,024 | 1,805 | 1,842 |
| 1,900 | 0,019 | 0,040 | 0,075 | 0,025 | 2.008 | 2,046 |

NOTE - National Committees may use minimum overall diameter requirements provided they are based on the minimum increases. The calculation is given in annex B.

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*Replace clause B.2 by the following:*

## B.2 Enamelled wires with a bonding layer

The minimum overall diameters are calculated on the following basis:

Grade 1B: Nominal conductor diameter + minimum increase of the underlying coating of grade 1B * + the minimum increase of the bonding layer.

Grade 2B: Nominal conductor diameter + minimum increase of the underlying coating of grade 2B * + the minimum increase of the bonding layer.

* For nominal conductor diameters smaller than 0,071 mm the minimum increase figure of the underlying coating is:

for grade 1B: 0,1 times the nominal conductor diameter;

for grade 2B: 0,2 times the nominal conductor diameter.

For the minimum increase of the bonding layer, see table below.

| Nominal conductor diameter mm | Minimum increase bonding layer mm |
|---|---|
| 0,020 | 0,001 |
| 0,022 | 0,002 |
| 0,025 | 0,002 |
| 0,028 | 0,003 |
| 0,032 | 0,003 |
| 0,036 | 0,004 |
| 0,040 | 0,004 |
| 0,045 | 0,004 |
| 0,050 | 0,005 |
| 0,056 | 0,005 |
| 0,063 | 0,005 |

For intermediate nominal conductor diameters, the minimum increase figure corresponding to the next largest nominal conductor diameter shall be taken.

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